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Aerial Suppression of Spruce Budworm with Bt on Passamaquoddy Indian Lands, Maine, 1983

Post-treatment Evaluation

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SUMMARY

The Passamaquoddy Indian Forestry Department treated 40,300 acres with Bt in 1983 to protect spruce and eastern hemlock from spruce budworm damage. Four Bt formulations were applied with Micronair AU-5000 rotary atomizers on Thrush aircraft. The objective to hold defoliation to less than 40 percent was achieved in all the sprayed areas. The average defoliation on spruce was 21.3 percent and populations declined from 10.64 budworms per branch to 0.31 budworms per branch, or an average reduction of 96.9 percent. On hemlock, the average defoliation was 8.6 percent, and populations declined from 7.39 budworms per branch to 0.05 budworms per branch, for an average reduction of 97.2 percent. Apparent spray drift into two of the three check areas did not allow for determination of natural population reductions and foliage protection due to the treatment.

INTRODUCTION

A biological evaluation (McCreery, 1982) found high spruce budworm populations and heavy past damage on about 40,000 acres of Passamquoddy Tribal Trust lands. The Passamaquoddy Indian Forestry Department (PFD) requested and obtained spruce budworm suppression funds. USDA Forest Service, Durham Field Office staff provided technical assistance to the PFD in implementing and evaluating the suppression project. The project objective was to hold spruce defoliation to less than 40 percent. This report summarizes the suppression project accomplishments.

PROJECT AREA

The project was conducted in SBW-infested spruce and hemlock stands on Tribal Trust land in Townships T4ND BPP, T5ND BPP, T5R1 and Indian Township, Maine. These lands, only recently purchased by the Tribe, have been infested by SBW for many years. Only a small portion of the lands has been protected in the past.

The total area sprayed was about 40,300 acres. This area was in 26 blocks ranging from 500 to 4,000 acres in size. Blocks were delineated on the basis of biological need for treatment as well as topography and forest cover to aid in navigation.

METHODS

Insecticides

Four commercial preparations of Bt were used: Dipel 6L and 8L (Abbott Laboratories), and Thuricide 32LV and 48LV (Zoecon Corporation). All the materials were applied in various field formulations from undiluted to 96 fl. oz. per acre to give 12 BIU's of active ingredient per acre. The only exception was Dipel 8L which was aplied undiluted at 8 BIU's per acre (16 fl. oz./ac). A sticker, RA-1990 (Rohm-Haas) was added at 2% rate of field formulation for all dilute applications.

Mixing and Loading

Mixing and loading services were provided by Chem-Pro of Oregon as subcontractors with Biggert Aviation.

Two semi-trailer tankers, each equipped with 3 compartments were used to mix the insecticide. Dipel and Thuricide were mixed in separate tankers to avoid incompatibility problems. Insecticide was unloaded from 55 gallon drums and stored in one of the compartments and water was stored in the other. The third compartment was used to mix the insecticide as needed. All liquids were metered as they were pumped to the compartments and to the aircraft. Insecticides were used within 24 hours after mixing. The sticker was added to the water, before the addition of insecticide. No mixing problems occurred with the sticker.

Aerial Application

The aerial application was done by Precision Air of Foley, AL, as sub-contractors to Biggert Aviation, Mesa, AZ. The aircraft were based at Princeton Airport, Princeton, ME. Spraying started on June 1, 1983 and was completed on June 9, 1983. The spray blocks were from 2 to 35 air miles from the airport.

Aircraft and Spray Equipment

Three aircraft of 300 gallon spray volume capacity each were used. One was a Thrush 600 and the other two were Snow Thrushes. All three were equipped with 8 Mini-Micronair rotary atomizers (AU 5000). Atomizers were equally spaced along the boom, beginning 18 inches from the outboard end. Atomizer pitch was set at 45°.

Aircraft Calibration and Characterization

The aircraft were calibrated at Princeton Airport on the basis of data from spray trials in Foley, AL (O'Neal 1983). At the spray trials, Thrush 600 aircraft were flown at 110 mph, 50 ft. above target at pump pressure of 40 psi. Twenty drops/cm^2 was the minimum standard for location of an effective swath at the Foley trial. Thuricide 48LV did not provide the 300 ft. swath width at Foley, but later achieved that swath during tests at Princeton Airport. A swath of 300 feet was used for all formulations.

Application

The three aircraft sprayed as a team. Team guidance was provided by a guide ship (Lincoln Air) equipped with a Loran C guidance system (Teledyne Corp.) which was used to locate team swaths. A monitor and spotter, both PFD employees, observed all applications from the monitor aircraft (Lincoln Air) 800-1000 feet above the terrain. The spotter called booms-on, booms-off over treatment areas. The monitor observed spray cloud behavior, team spacing, and weather conditions.

Meteorology

Weather conditions were monitored by ground personnel within treatment areas, the monitor aircraft and through long range forecasts provided by the Maine Forest Service and Bangor International Airport Flight Service. The work plan specified these weather conditions as acceptable for Bt application:

a. Drip dry foliage within or in close proximity to spray blocks.

b. No rain forecast for four hours.

c. Windspeed >2 mph but <15 mph.

d. No inversion conditions present at or below 100 feet above canopy.

e. Air temperature forecast to be 55°F or higher within 36-48 hours.

f. Air temperature above 32°F at application time.

One block was treated less than four hours before rain. A reduction in efficacy in this block was not apparent in preliminary analysis.

Larval and Bud Development

Larval and bud development was monitored at 8 sites - 5 in the spray areas and 3 in the check areas. At each site, 5 codominant spruce and 5 hemlock were marked for development sampling. Each sample consisted of one 36-inch branch cut from the mid-crown and brought to the field laboratory. Collections were made at 3 to 5 day intervals until spraying was completed. Laboratory examinations were completed on the same day as collections.

In the laboratory, all larvae (not more than 100) found on the branches were removed and their location recorded as follows:

1. Wandering on branches
2. Mining in the needles
3. Mining in the buds
4. Other (loose in the bag, etc.)

Larval instars were determined from head capsule measurements and body coloration. Larval index was determined using method described by Dorais and Kettela (1982) and the results are summarized in Table 1 and Table 2.

Bud development index is shown in Table 1. This system was developed by D. G. Mott formerly of the PFD staff. The classes were defined as follows:

Class 1 - Tight buds, no green showing at the base of the bud.

Class 2 - Bud expanding, $\leq$2mm of green showing at the base of the bud.

Class 3 - Bud expanding, >2mm of green showing at the base of the bud.

Class 4 - Bud cap off.

Insecticide application was timed to start when most of the larval had left needle mines (more than 50%).

Table 1.--Larval and Bud Index Values for the Passamaquoddy Spray Program (First and Last Spray Day), 1983.

SPRUCE

Location	06/01/83 Larval Index	06/01/83 Bud Index	06/09/83 Larval Index	06/09/83 Bud Index
T4ND 1	3.4	1.0	4.0	2.5
2	3.0	2.1	4.0	3.3
3	3.0	1.0	4.0	2.0
T5ND 1	3.0	1.0	3.8	1.2
2	3.5	1.5	4.6	2.5
INDIAN TWP 1	3.0	1.0	3.8	3.1
2	3.0	1.5	3.4	3.8
3	3.0	1.0	4.0	2.0

HEMLOCK

Location	06/01/83 Larval Index	06/01/83 Bud Index	06/09/83 Larval Index	06/09/83 Bud Index
T4ND 1	3.2	2.9	3.8	4.0
2	3.8	2.6	5.0	4.0
3	NS[1/]	NS	NS	NS
T5ND 1	3.6	2.5	4.0	4.0
2	3.6	1.9	4.8	3.3
INDIAN TWP 1	3.6	1.5	4.2	4.0
2	NS	NS	NS	NS
3	4.6	3.0	5.4	4.0

1/NS=not sampled

Table 2.--Larval Behavior During and After the Passamaquoddy Spray Program, 1983.

SPRUCE

Date/ Behavior	SAMPLING LOCATION T4ND 1	T4ND 2	T4ND 3	T5ND 1	T5ND 2	INDIAN TWP 1	INDIAN TWP 2	INDIAN TWP 3
06/01/83								
% Wandering	27	33	57	24	26	27	56	19
% in Needles	61	50	17	70	51	59	41	81
% in Buds	9	11	15	0	12	6	3	0
% Other[1/]	3	6	11	6	11	8	0	0
06/09/83								
% Wandering	7	62	8	11	39	8	20	0
% in Needles	0	0	0	4	0	0	0	23
% in Buds	90	16	61	82	33	86	70	0
% Other	3	22	31	3	28	6	10	77
06/15/83								
% Wandering	32	51	77	20	82	86	93	100
% in Needles	0	0	0	0	0	0	0	0
% in Buds	45	46	19	74	6	5	0	0
% Other	23	3	4	6	12	9	7	0

[1/]this category includes the percentage of larvae webbed either on or near buds

SPRAY EFFICACY EVALUATION

This report examines the data only from the overall project accomplishment point of view. A later report will examine differences between products and formulations.

Samples and Sample Clusters

A total of 45 sample clusters were established in 10 treatment blocks. Each cluster was a line of 20 dominant/codominant spruce trees spaced about 50 ft. apart, across the anticipated spray swaths. Paired hemlocks and spruces were sampled at one cluster in 8 of the blocks.

Additionally, 3 check blocks were established in widely separated areas at least 1/2 mile outside spray blocks. Each check block had 4 clusters established in a manner similar to spray blocks. Despite these precautions, Bt deposits were found in 2 of the 3 check blocks.

Prespray Survey

Prespray samples consisted of one 18 inch long branch taken from the mid-crown of each sample tree. Collections were made 2 to 3 days before spraying. The branches were bagged, labelled and delivered to a laboratory for examination. The average number of larvae per 18 inch branch was determined in the laboratory.

Postspray Survey

Post-spray samples included two branches, each 18 inches long, taken from the mid-crown of the sample trees. The samples were collected about 40 days after spraying when larval feeding was completed. This coincided with ten percent adult emergence. Again, branches from each tree were bagged, labelled and delivered to the laboratory. In the laboratory, the average number of budworm per branch, and the degree of defoliation was determined. The defoliation for each branch was determined from 25 shoots rated in 10 percent defoliation classes.

Spray Deposit Assessment

Spray coverage was evaluated at the sample clusters in 9 of the 10 treatment areas and in all the check areas. Foliage samples were collected from the mid-crown and from the lower crown of each sample tree. In each treatment area, deposit assessment was made for 5 trees in each of the selected clusters. In addition, millipore filters were exposed on 3 ft. stakes near sample trees. In each treatment area 5 filters were set out in each cluster. The filters were set out 8-12 hours before spraying and picked up within 6 hours after spraying. Foliage samples were taken as millipore filters were collected.

About a month later, all deposit samples were placed on tripticase soy agar plates and the spray coverage determined. For foliage samples, 20 old needles from each branch were placed on agar. After incubation, the pro-

portion of needles producing Bt colonies were determined. Sample colonies from each dish were examined under a microscope to confirm the presence of Bt crystals. The millipore filters were handled the same way, except that the number of colonies per square centimeter were determined. Table 4 presents the average percentage of needles producing Bt colonies and the average number of colonies per cm^2 on the milipore filters for each block.

Field Laboratory

Foliage examination was done in a laboratory operated by the PFD. Personnel included experienced and inexperienced workers. Branches were brought to the lab and kept refrigerated until they were examined. Branches were examined within a week after collection in the field.

RESULTS

Defoliation

The average defoliation for all the sprayed blocks was 21.3 percent for spruce and 8.6 percent for hemlock, (Table 3). Both defoliation levels are well below the 40 percent defoliation set as acceptable in the objectives. Defoliation reduction attributable to Bt treatments cannot be determined, since the check areas appear to have received spray drift.

Table 3.--Spruce budworm population changes and defoliation in the 1983 Passamaquoddy Bt treatment areas

Block	No. Clusters	Spruce Budworm Populations: Prespray No/Branch S[1/]	Prespray No/Branch H[2/]	Postspray No/Branch S	Postspray No/Branch H	Percent Reduction S	Percent Reduction H	Defoliation Percent S	Defoliation Percent H
43	4	11.4	10.1	0.10	0.10	99	99	14	25
44	4	8.2	5.1	0.40	0.10	95	98	18	16
45	4	14.7	--	0.50	--	97	--	27	--
46	4	10.5	12.9	0.40	0.03	96	99	20	3
47	4	16.2	--	0.50	--	97	--	25	--
48	4	8.6	7.5	0.40	0.40	95	95	23	4
49	3	8.3	9.2	0.10	0.10	99	99	18	1
71	7	13.8	4.8	0.20	0.03	99	99	28	10
72	5	9.8	8.2	0.20	0.01	98	99	20	4
73	6	4.9	1.3	0.30	0.13	94	90	20	6
Average		10.64	7.39	0.31±	0.05	96.9	97.2	21.3	8.6
Standard Error		± 1.09	±1.27	±0.11	±0.04	0.59	1.15	1.39	2.88

1/Spruce

2/Hemlock

Budworm Population Reduction

Spruce budworm populations on spruce in the treatment area declined from 10.64 budworms per 18-inch branch to 0.31 budworms per branch, to give an average of 96.9 percent population reduction (Table 3). On hemlock, the population declined from 7.39 budworms per 18-inch branch to 0.05 budworm per 18-inch branch, to give a 97.2 population reduction. Again, the presence of Bt deposit in the checks do not allow comparisons of population changes between sprayed and unsprayed areas to estimate percent population reduction due to spraying. However, the treatment appears very successful, since rarely do spruce budworm populations naturally decline more than 80 percent.

Table 4.--Percent of needles with Bt and number of Bt colonies per cm^2 in the Passamaquoddy spray areas.

Block	Foliage Sample Mid-crown %	Foliage Sample Low-crown %	Millipore Filters No./cm^2
43	59	70	34
44	96	97	24
45	--	--	--
46	88	86	22
47	73	66	171
48	52	48	19
49	49	56	90
71	51	42	15
72	36	28	14
73	44	41	45
Average	60.9	59.3	48.2
Standard Error	± 6.8	± 7.5	±17.3
Unsprayed Area			
1	5	4	1
2	13	42	4
3	0	0	--

Spray Coverage

Spray deposit in the treated areas indicates good coverage (Table 4). No significant differences in deposit were found between mid-crown and lower crown needle samples (60.9 percent vs. 59.3 percent of needles with Bt). On millipore filters, the average count was 48.2 colonies per cm^2. However, one block (47) had an average of 171 colonies per cm^2, suggesting multiple coverage. Without that block, the average deposit was 32.9 colonies per cm^2.

REFERENCES

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